be adopted in this class of cases will be mentioned when we come to the consideration of complete and incomplete anchylosis.

Anæsthetics.—Shall we use anæsthetics in orthopedic operations?

A majority of operations for the relief of deformities of the foot I prefer to perform without resorting to their use. The pain connected with the operation is very slight, hence the administration of an anæsthetic is not necessary as an act of humanity. The child cries through fear of the knife principally; and there are some instances in which the nervous system of the patient is such, that great fright may bring on convulsions. Of course under such circumstances the administration of an anæsthetic is proper. The contractured tendons should be brought into as bold relief as possible, and the irritation produced by the crying of the child will cause an additional contraction, that will bring it more distinctly into view. In all the more severe operations, anæsthetics should always be used.

LECTURE V.

DEFORMITIES.

Treatment (continued).—Mechanical Appliances —General Principles governing their Use.—Elastic Tension.—Adhesive Plaster.—Electricity.—Instrument for testing Muscular Tissue.—Cases.

Gentlemen: We will continue the study of our subject this morning, by first directing our attention to the employment of mechanical appliances in the treatment of deformities. Such appliances are of great service, and, in fact, are very essential.

Until very recently the use of mechanical contrivances has been the most valuable means of rectifying deformities possessed by the orthopedic surgeon, but, with the improvements we now have at our command, we are enabled to do more toward the restoration of a deformed part in a single day than could formerly be done in weeks or months. Restoration in fact is, in many instances, only possible when the operation is followed by a properly-applied apparatus.

Great ingenuity has been displayed in the manufacture of different instruments, and many complicated contrivances have been devised for the application of mechanical force. Occasionally, demand upon the ingenuity and skill of the mechanic is required; but, as a general rule, elaborate and complicated instruments should be avoided. The principal requisites of an orthopedic apparatus are, simplicity, facility of application, and lightness as far as compatible with the object to be accomplished by its use. It should never encircle a limb or trunk in such manner as to interfere with the circulation, nerve-currents, or natural movements of the part. I would caution you against such interference. You can all easily understand that, if the muscles and the vessels supplying them—the nerves, veins, and arteries—should be girdled with straps or heavy instruments, binding them down upon the bone, the effect would be to obstruct the supply of blood to the limb, with its attendant disaster, gangrene. Thus, a badly-contrived instrument will rather add to the gravity of a case than relieve it. For an apparatus to be truly useful, it should be as simple in its construction as circumstances will permit, and should compress the limb in its circumference as little as possible. It should act in its tractile force gradually and constantly, and, as the line of deformity is slowly changing its direction, it becomes very necessary that the apparatus be frequently removed and reapplied, or adapted to the new line of distortion. The persons in charge of, and using the apparatus, should thoroughly understand their manner of action, be perfectly acquainted with their mechanism, and the object to be gained by their application. At the outset the practitioner should adapt the instrument to the deformity, and not the deformity to the instrument, as is too frequently attempted. Proceed in a gentle manner until the first difficulty is overcome. The pain experienced in the part soon wears off as the mind becomes more tranquil, and then you can, day by day, bring to bear upon it such force as will tend to secure the desired object.

In the use of any apparatus, if you put on the screws and straps by which it is adjusted, and tighten or loosen and strengthen them as opportunity offers without any order or design, you are liable to increase the existing difficulty and to retard recovery. Therefore, you must make it your maxim in these cases to "make haste slowly." The principle which should con-

trol your action in the treatment should be, never advance too rapidly, lest it arrest the process of cure; by steady and appropriate progress your object is really earlier accomplished, and usually without risk.

In the choice of a mechanical apparatus you should be guided not only by its adaptability to the member to which it is to be applied, but also by your acquaintance with its mechanism and use; and you should be positive that you understand the principles upon which it is constructed before you purchase or attempt to use it. Get true principles of treatment into your heads, and then design some form of mechanical apparatus, if necessary, to put them into practical application.

There is another important rule which should influence your management of all paralytic deformities, and also many other cases, especially those in which it becomes necessary to overcome muscular contraction, or to retain muscles in a state of rest for a considerable length of time; it is this: *permit as far as possible the natural motion in the parts involved in the deformity.*

The joints and muscles of the human body were designed by the Creator of all things for active motion, and as far as is practicable the natural movements of the body should be retained, stimulated, and strengthened. It is for this reason that all treatment of paralytic deformities by means of fixed apparatus is to be condemned. The total, absolute rest which must necessarily occur in a muscle when secured in some fixed apparatus, if too long continued, will certainly induce such structural changes as will preclude all possibility of ever overcoming the deformity by restoring to the muscle its normal power.

Elastic Tension.—As has already been stated, subcutaneous tenotomy was first applied to the relief of deformity in the year 1830 by Stromeyer. That operation marked a new era in orthopedic surgery, and for many years the operation of tenotomy was exclusively relied upon for affording relief of the contracted tendons.

Yet, in the progress of time, we have learned still more; and in my own experience I have been enabled to test the correctness of the now established principle of *extending a contracted muscle*, by the *constant* application of an elastic force, moderately but persistently applied. This will, in the majority of instances, accomplish the object fully as efficiently as tenotomy, where the

muscle has not already undergone structural changes, or, in other words, become contractured; and it is infinitely better for the future usefulness of the limb involved, although sometimes much more tedious in producing the result.

I have made use of elastic extension, by means of India-rubber, ever since my pupilage, having been taught its value by my preceptor, the late Dr. David Green. The difficulty in its application, in many instances, without expensive and cumbersome machinery to secure its attachment, in order to obtain its force, was the only obstacle to its universal employment.

This difficulty has been happily overcome within a few years by the simple yet beautiful contrivance first suggested by Mr. Barwell, of London, whereby we can secure the attachments, for the origin and insertion of the elastic power, to any part of the body, by the use of small strips of tin made permanent at the place desired, by means of adhesive plaster and a roller. In this way we can imitate the action of almost all the muscles of the body. We get rid of the weight of cumbersome machinery, which is so serious an inconvenience in all paralytic deformities, and the persistent action of the elastic during the hours of sleep—which is Nature's anæsthesia—renders it an agent of most wonderful power, capable of overcoming an immense number of serious deformities.

This suggestion of Barwell's will make almost as great an advance in orthopedic practice as did the suggestion of Stromeyer of subcutaneous tenotomy. The rules for its application, and the diagnostic differences of the cases where it is applicable from those where the knife becomes a necessity, I shall lay down more fully in my future lectures.

Adhesive Plaster.—In all cases where it is desirable to maintain long-continued traction by means of adhesive plaster, the most reliable article that can be used is that manufactured by Mr. Maw, No. 11 Aldersgate Street, London, and known by the name of "Maw's Moleskin Plaster." Plaster spread upon Canton flannel may be used, but it is not nearly as good as the "Moleskin Plaster."

I receive complaints almost daily from doctors in the country that they cannot make the plaster stay on more than a day or two. In the first place, they put it on too hot; the heat destroys the vitality of the epidermis, and it peels off the same as from a

blistered surface, and, of course, carries with it the point of attachment. In the next place, they do not thoroughly knead the strips of plaster and mould them uniformly to the limb before subjecting them to the strain of traction. If a reliable article is used, and these precautions taken, there need be no trouble with regard to making the plaster adhere firmly to the surface. As an additional precaution, however, it is important that the surface to which the plaster is to be applied should be clean and dry. There is another exceedingly important point relating to its reapplication, as in a second dressing: when the plaster has been on a limb for a long time, and then removed, there will be found more or less dead scarf-skin on the surface; this must be completely removed before making another application of plaster; we must have a clean, solid surface in order to get a firm foothold, so to speak. If the plaster is applied over the dead skin which is found remaining on the surface, it would be like frescoing an old wall without cleaning it; your labor would be in vain, and your money lost; so here, if you apply the plaster before the dead epidermis is removed, you will run the risk that it will blister the surface in some places, while it fails to adhere in others; and the whole object of the dressing will be defeated in consequence of neglecting to take this seemingly trivial precaution.

The surface of the limb can be very easily cleansed by first applying a small quantity of sweet-oil, and afterward removing this with soap and warm water. If the surface becomes broken in removing the old plaster, the new should not be applied until all abrasions or fissures are thoroughly healed. In some cases it may be necessary to place the patient in bed for a few days, or resort to some modification of the apparatus which is employed, in order to secure a healthy, clean surface, to which the plaster can be reapplied.

This matter of selecting a proper kind of plaster, together with directions regarding its application, and the precautions to be taken, may appear to you like insignificant items; but they are really very important. For, unless you have a reliable adhesive plaster (the ordinary kinds in common use being worthless for this purpose), all your efforts at long-continued traction will prove entirely useless, and your plan of treatment will utterly fail. The value of this agent, and the necessity of using a reliable article, will be demonstrated farther on in the course.

Electricity.—Of the theories respecting the *modus operandi* of this agent I do not propose to speak. Its apparent value as a means for restoring vitality to paralyzed muscles is indisputable. There are a few rules which should regulate its application, and it is to these alone that I purpose calling your attention. I regard them of the utmost importance, and therefore ask your careful attention to their observance:

1. When applying electricity for the restoration of paralyzed muscles, do not apply it *too long*. Three or five minutes every day, or every other day, is sufficient in a majority of cases.

2. Do not apply it *too strong*. A strong current is very likely to give rise to over-fatigue of the muscles; this effect is especially liable to be produced when such a current is continued too long. Over-fatigue of the muscles induced in this manner will be as positively injurious as that induced by any other means, and all over-fatigue of paralyzed muscles must be carefully avoided.

3. Always restore the muscle as nearly as possible to its normal position, by means of some artificial support, and retain it there, approximating its origin and insertion before the battery is applied. The principle is, the paralyzed muscle should be placed in such a position that, when stimulated to contract in response to the electric current, it can do so *without carrying any weight*. If a paralyzed muscle is compelled to act without this assistance, permanent damage rather than permanent benefit will be likely to result.

You will always recollect, therefore, to approximate the origin and insertion of all paralyzed muscles before applying the electric current. Muscles that have entirely lost their excitability upon application of the electric current, are incapable of contraction. The production of even a few contractions will indicate to you that treatment persistently applied will finally greatly increase the power of the muscles. But if the contractions are forced, as is exceedingly apt to be the case unless great care is exercised, it will be found that, perhaps, the next day no contractions can be obtained. The slight power of contraction which some muscles may have is, doubtless, many times entirely destroyed by the excessive use of the electric current, the muscles being overfatigued by this stimulus the same as they would be by overwork.

For the purpose of determining whether a muscle has undergone fatty degeneration, it is only necessary to remove a small portion by instruments specially devised for that purpose, and then submit it to microscopical examination. (*See* Fig. 12,

Fig. 12.

Duchesne's instrument for removing muscular tissue.) One precaution, however, is to be taken, namely, to examine the muscle suspected at different points from one end to the other. When this has been done, your prognosis can be established relative to the restoration of lost muscular power by means of the electric current. The principles here referred to are well illustrated by the following cases:

Case. *May* 22, 1867.—Mary C., aged eleven years; father died seven months before her birth, of softening of the brain; mother was healthy, and child robust and healthy until nine months old. She was put to bed one night in perfect health, and was found in the morning paralyzed in both arms and legs. In a few weeks the arms and right leg partially recovered—the arms are well at the present time. The right leg again became paralyzed a year ago.

There is talipes equino-varus of the right foot, and valgus of the left. Both limbs are very much atrophied, but the left much more than the right. The right limb responds to the galvanic current; the left limb gives no response in any of its muscles, and, testing the muscles by Duchesne's method, they were found to be fatty. This test was applied by a single puncture to the gastrocnemius and also one to the quadriceps femoris, and, they proving in both instances to be fatty, I gave an unfavorable prognosis respecting that limb, and stated to the family that treatment of it would be useless, as it never could recover.

The tendo-Achillis of the right leg and the biceps and outer hamstring of the same limb were contracted, but, yielding under elastic tension and giving no reflex spasm on point-pressure, were not divided. After continued application of electricity to the paralyzed muscles of this limb, bathing with hot-water and the application of elastic tubing to assist the paralyzed muscles, her

general health was much improved and the right leg increased in size.

After some weeks of treatment I accidentally applied the battery to the left limb, and was surprised to find muscular contraction. I called the attention of my assistant to this fact, and again applied the battery to show him that the muscle responded, when no response was given. He replied that he was certain there was no contraction, as he had examined that muscle under the microscope and found fatty degeneration, and, as we could not make it contract under the current, I concluded that he was correct, and that possibly I might have been mistaken in my first observation. Three days afterward, in making the same experiment, the muscles gave an evident response; and, not wishing to be mistaken a second time, I repeated the experiment quite a number of times and satisfied myself that the muscle responded to the battery, and again calling the attention of my assistant to this muscular contraction, and applying the battery, obtained—no result. Two days afterward, upon making the same experiment, the muscles contracted, when the attention of my assistant was again drawn to the fact, and we both observed the contractions very distinctly. These contractions were repeated quite a number of times during the space of a minute, and then ceased altogether, and no force that we could apply with the battery would obtain any response.

Two days afterward the same experiment was performed, with precisely the same result, showing that the paralyzed muscles can make but few responses to the galvanic current without becoming so much exhausted as to require repose, and that we should, therefore, never continue our application too long in these cases.

Another fact was proved by this case, that although the points of the muscles that were examined proved to be fatty, there must have been some other portion of the muscles that had not yet undergone this change; and, consequently, before we can pronounce the case absolutely hopeless we must explore the muscles their entire length in different places.

I had already applied an instrument to the other limb, but had done nothing for the left one, having considered it useless to do so. I now, however, applied an instrument to this leg also, which permitted all the natural movements (*see* Fig. 13), the

power of the left thigh being supplied mostly by springs working over the knee-joint of the instrument. The right foot is

Fig. 13.

kept in position by an elastic strap running from toe of shoe to a belt around the leg above the calf; two horizontal steel pieces, with joints at the ankle, extend from the sole of the shoe to this belt. (*See* Fig. 13.)

This girl had been for seven years under treatment in an orthopedic institution, so called, where she had worn a long iron splint on the left limb, having neither a joint at the ankle nor knee, and nothing had been done for the right leg.

July 11, 1867.—She can now, by the aid of the instruments, stand alone and take one or two steps. With crutches walks well, putting one foot before the other. She has improved greatly, generally as well as locally, and returns home to continue treatment. The contraction of right leg is greatly improved.

The following extracts from letters show the progress of the case:

"*October* 14, 1867.—She has gained eleven pounds in weight. The left leg (the worst one) measures one inch more in size, both above and below the knee, and she is able to move it a little in various ways in which she could not move it formerly. The right leg is much straighter at the knee."

"*July* 20, 1868.—Mary's foot is now quite well, and she improves constantly in using it, and she walks with comfort.

"Very respectfully, E. C."

Remarks.—The facts observed in this case respecting the action of the galvanic current on the muscles of the left leg, brought to my mind another case in which I had abandoned the treatment two years previous, on account of no muscular contraction being perceived under the influence of the battery, and had told the parents that their child would be compelled to resort to mechanical means during the rest of her life. I felt justified in making this statement at the time, as I could obtain no response of the muscle myself, and as she had already been under the treatment of one of our best electricians for many months without any benefit.

Taking these facts into consideration, as before said, I sent for the case, the history of which is as follows:

Case. *December* 24, 1868.—Pauline K., aged five years and nine months, perfectly well until fifteen months old, when left foot was discovered to be paralyzed. Was treated at that time by Dr. Peter Van Buren. A few months later Dr. Henschel directed a shoe to be applied which she has worn ever since. Prof. Gross, about three years ago, proposed to cut the tendons, but it was not done. About two years since, Dr. Guleke applied electricity for nearly nine months, without any apparent benefit. She was then brought to me for treatment, and finding no response to the battery when applied to the gastrocnemius muscle, even when needles had been inserted in it, and satisfied that Dr. Guleke had given her all the benefit that electricity afforded, I stated to the parents that further treatment would be useless, and simply directed a shoe to be worn, with an artificial gastrocnemius, as seen in Fig. 14. This was in the latter part of 1866.

When she returned to me in December, 1868, her foot had increased somewhat in length and size, but the muscles of her leg were no better developed than when I saw her two years before, and as here represented in Fig. 15 (as drawn by Dr. Yale), unsupported by the shoe.

When she attempts to walk without the instrument, the weight of her body is supported on the extreme posterior part of

Fig. 14.

the os calcis. The foot could very readily be brought to its natural position, in which place it was held during the application of

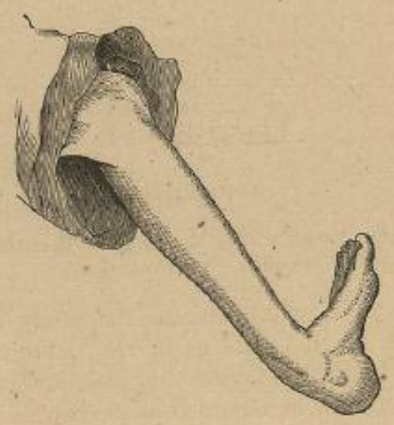

Fig. 15.

the galvanic current, which was continued for half a minute or a minute. After the action of the battery one-eightieth of a grain of strychnine was injected into the gastrocnemius, and the shoe with the elastic force applied as before.

The battery was applied in this way from half a minute to a minute at a time each day, for six weeks, before any perceptible contractions of the muscles could be observed. The injections of strychnine were repeated every eight or ten days for some three months.

The improvement for the first six months was very slight indeed, but still noticeable, and the time occupied in the application of the battery was increased to three or five minutes as the muscles became stronger; but, even then, it was observed that after a few vigorous contractions the muscles would refuse to respond to the same power of the battery.

May, 1870.—Very much improved; begins to have voluntary power over the muscles.

November, 1870.—Can make a forcible, voluntary contraction.

May, 1872.—Can extend the foot almost to the normal position when sitting down, but incapable of walking without artificial support.

The muscles of the calf of the leg have increased very much in size, but exact measurements were neglected to be taken. She still continues to use the shoe with elastic gastrocnemius, as seen in Fig. 14.

LECTURE VI.

DEFORMITIES.

Treatment (continued).—Manipulation.—*Massage*.—Dry Heat.—Baths.—Inunction.—Gymnastics.—Medicinal Agents.

Gentlemen: We will continue the study of the general principles which are to guide us in the treatment of deformities, and to-day I will first invite your attention to manipulation.

Manipulation may be regarded as the natural remedial agent for the cure of a deformity. In very many cases, so far as the